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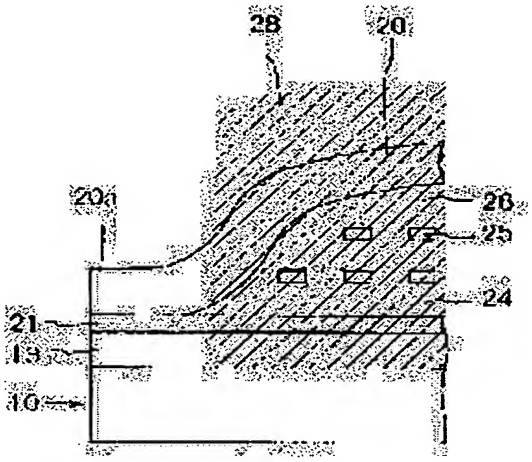
(54) PRODUCTION OF MR HEAD

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a method for the production of an MR head by which fluctuation of the height of an upper magnetic pole can be eliminated as much as possible and the MR head having stable writing characteristics can be produced.
SOLUTION: This method includes a process of exposing an upper magnetic pole top end and a lower magnetic pole 13 corresponding to the upper magnetic pole top end through an aperture and of forming a second resist film having 10 to 15 μm thickness on the inner wall and 1 to 3 μm distance from the floating face of the aperture inside wall of the upper magnetic pole top end, a process of ion milling to irradiate the inside of the aperture with ion beams at any incident angle except for 0° by using the second resist film as a mask to etch the exposed lower magnetic pole 13 to specified depth while rotating a substrate, and a process of removing the second resist film.



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] The lower magnetic pole which serves as the magnetic-shielding film of a magneto-resistive effect mold head, and the up magnetic pole formed through the gap layer which consists of a non-magnetic material on this lower magnetic pole, In the manufacture approach of an MR head that the coil layer which is insulated and formed in a lower magnetic pole and an up magnetic pole, and guides a record field to a lower magnetic pole and an up magnetic pole was prepared The laminating process which makes the magneto-resistive effect mold head of a large number containing said lower magnetic pole on a substrate, The process which forms said non-magnetic material layer on this lower magnetic pole, and the process which forms said up magnetic pole with width of face narrower than said lower magnetic pole on this non-magnetic material layer, The reactive-ion-etching process which removes said non-magnetic material layer which exposed as a mask the 1st resist coat which was made to expose said up magnetic pole point and said non-magnetic material layer near [this] an up magnetic pole point, and was formed, The process which removes the 1st resist coat, and said lower magnetic pole corresponding to said up magnetic pole point side and this up magnetic pole point side are exposed by opening. this — The process in which the distance from the floatation side of the opening internal surface by the side of said up magnetic pole point forms the 2nd resist coat whose thickness is 10-15 micrometers by 1-3 micrometers, Said 2nd resist coat is used as a mask, rotating said substrate. The manufacture approach of the MR head characterized by irradiating an ion beam by the angle of incidence of arbitration other than 0 degree in said opening, and including the ion milling process which carries out necessary depth etching of said exposed lower magnetic pole, and the process which removes said 2nd resist coat.
[Claim 2] Said non-magnetic material is SiO2, Ta 2O5, Si3 N4, TiO, and WO3. The manufacture approach of the MR head according to claim 1 characterized by being one sort or two sorts or more of non-magnetic materials.
[Claim 3] Said reactive-ion-etching process is CF4. O2 The manufacture approach of the MR head according to claim 1 or 2 characterized by laying said substrate on a carbon tray and performing it using mixed gas.
[Claim 4] Said reactive-ion-etching process is CHF3. The manufacture approach of the MR head according to claim 1 or 2 characterized by laying said substrate on a quartz tray and performing it using gas.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the manufacture approach of an MR head.
[0002]
[Description of the Prior Art] The magneto-resistive effect mold combined head (henceforth an MR head) which consists of a magneto-resistive effect mold head for playback and an inductive head for record (henceforth ID head) carries out the laminating of the necessary layer on the Al-Chick substrate (wafer), and are made. [many] The front view and drawing 10 which looked at drawing 9 from the floatation side side of an MR head are the fragmentary sectional view of ID head section of this MR head.
[0003] In drawing, 10 is a magneto-resistive effect mold head, and 12 is an inductive head. The magneto-resistive effect mold head 10 is formed from the up shielding film 13, the lower shielding film 14, the alumina film 15 and 16, the central field 17, the edge field 18, and 19 grades.
[0004] A NiFe alloy (permalloy) is used and the up shielding film 13 and the lower shielding film 14 are formed with plating. The central field 17 comes to carry out the laminating of the Ta film for separating magnetically the NiFeCr film, NiFe film, and NiFeCr film for applying a horizontal bias field to the NiFe film and NiFe film which have the MR effectiveness to the order of the NiFeCr film, Ta film, and the NiFe film from a lower shielding film side.
[0005] It has joined as electrically as the central field 17, and the edge fields 18 and 19 consist of CoPtCr film 18a and 19a which supplies a vertical bias field to the NiFe film of the central field 17, and Au film 18b and 19b which supplies a current to the central field 17. MR component consists of a central field 17 and edge fields 18 and 19.
[0006] The up shielding film 13 makes the lower magnetic pole of the ID head 12 serve a double purpose. On this lower magnetic pole 13, projected part 13a of the same width of face is mostly formed with the up magnetic pole 20 of the ID head 12. The gap layer 21 which consists of a non-magnetic material is formed on projected part 13a, on this gap layer 21, the up magnetic pole 20 is formed and the ID head 12 is formed. Projected part 13a of the same width of face is mostly formed for controlling the so-called write-fringing (write-in blot) with the up magnetic pole 20 on the lower magnetic pole 13.
[0007] Drawing 10 shows the production process of the ID head 12. As shown in drawing 10 (a), the lower magnetic pole 13 is formed with plating on the alumina film 16, and the non-magnetic material layer 21 is formed by sputtering on this lower magnetic pole 13. And a resist pattern 22 is formed in the both sides of the part used as the up magnetic pole 20.
[0008] Subsequently, as shown in drawing 10 (b), the up magnetic pole 20 is formed with plating by using a resist pattern 22 as a mask. Next, as shown in drawing 10 (c), the non-magnetic material layer 21 exposed by reactive ion etching by using the up magnetic pole 20 as a mask is removed.
[0009] And as shown in drawing 10 (d), necessary depth etching of the lower magnetic pole 13 is carried out by ion milling, and projected part 13a is formed. The up magnetic pole 20 is also etched into coincidence in that case, and height becomes low. The up magnetic pole 20 expects beforehand this part that etches and becomes low, and makes plating thickness that much thick.
[0010]
[Problem(s) to be Solved by the Invention] By the way, the following technical problems consist in the manufacture approach of the above-mentioned MR head. That is, although many above-mentioned MR heads are made on a substrate (wafer), in case a wafer makes the up magnetic pole 20 from having a certain area with plating as mentioned above, it has the technical problem that the variation in height arises in the up magnetic pole 20 of the MR head which the difference was made to plating thickness, therefore was obtained eventually, and write in by each MR head and variation arises in a property, by the periphery [of a wafer], and center-section side.
[0011] Then, the place which this invention is made that the above-mentioned technical problem should be solved, and is made into the object is to offer the manufacture approach of an MR head that the variation in the height of an up magnetic pole is canceled as much as possible, and the stable MR head which writes in and has a property can be manufactured.
[0012]
[Means for Solving the Problem] This invention is equipped with the next configuration in order to attain the above-mentioned object. Namely, the lower magnetic pole which serves as the magnetic-shielding film of a magneto-resistive effect mold head, The up magnetic pole formed through the gap layer which consists of a non-magnetic material on this lower magnetic pole, In the manufacture approach of an MR head that the coil layer which is insulated and formed in a lower magnetic pole and an up magnetic pole, and guides a record field to a lower magnetic pole and an up magnetic pole was prepared The laminating process which makes the magneto-resistive effect mold head of a large number containing said lower magnetic pole on a substrate, The process which forms said non-magnetic material layer on this lower magnetic pole, and the process which forms said up magnetic pole with width of face narrower than said lower magnetic pole on this non-magnetic material layer, The reactive-ion-etching process which removes said non-magnetic material layer which exposed as a mask the 1st resist coat which was made to expose said up magnetic pole point and said non-magnetic material layer near [this] an up magnetic pole point, and was formed, The process which removes the 1st resist coat, and said lower magnetic pole corresponding to said up magnetic pole point side and this up magnetic pole point side are exposed by opening. this — The process in which the distance from the floatation side of the opening internal surface by the side of said up magnetic pole point forms the 2nd resist coat whose thickness is 10-15 micrometers by 1-3 micrometers, Said 2nd resist coat is used as a mask, rotating said substrate. It is characterized by irradiating an ion beam by the angle of incidence of arbitration other than 0 degree in said opening, and including the ion milling process which carries out necessary depth etching of said exposed lower magnetic pole, and the process which removes said 2nd resist

carry out it to an ion beam, ion milling is performed, rotating the axis for a fixture as a core. The resist coat 30 after [2nd] ion milling termination is removed.

[0028] Technique, for example, the milling by the carbonated argon gas, in which ion milling is well-known is performed. Point 20a which has exposed about the lower magnetic pole 13 and the up magnetic pole 20 by ion milling is also etched. The arrow head in drawing 5 shows the exposure situation of the ion beam at the time of seeing a substrate (wafer) side fixed. Moreover, drawing 6 shows the exposure range of an ion beam. When an ion beam is irradiated from the internal-surface 32a side of opening 32 like a graphic display, an ion beam may be covered by the 2nd resist coat 30, and may not be irradiated by point 20a of the up magnetic pole 20.

[0029] As mentioned above, the up magnetic pole 20 is made by plating in the phase of a substrate, and a difference comes out of it to plating thickness by the central site the circumference side of a substrate. As mentioned above, although an ion beam has the location covered by the 2nd resist coat 30, also in this electric shielding location, an ion beam becomes that it tended to irradiate the head side 20a if the plating thickness of the up magnetic pole 20 is thick, and if plating thickness is thin, the case where an ion beam does not reach the head side 20a will arise.

[0030] That is, since the exposure rate of the ion mill which carries out incidence to point 20a of the up magnetic pole 20 changes with thickness of the up magnetic pole 20, the amount of etching increases according to the shadowing effectiveness of the 2nd resist film 30, so that thickness is thick, and the amount of etching decreases so that thickness is thin, even if variation is in thickness (plating thickness), on the whole, the height of point 20a of the up magnetic pole 20 comes to gather.

[0031] In this case, the shadowing effectiveness becomes large, so that the shadowing effectiveness of the up magnetic pole 20 decreases, so that the above-mentioned internal-surface 32a location of opening 32 is kept away from the floatation side A, and the height of the 2nd resist coat 30 is made high. Drawing 7 shows the amount of loss of weight of the up magnetic pole 20 by ion milling (axis of ordinate) to the height (thickness, axis of abscissa) of the up magnetic pole 20. It turns out that there are so few amounts of loss of weight that there are so many amounts of loss of weight that the height (first stage) (3.75-4.75 micrometers) of the up magnetic pole 20 is high and initial height is low.

[0032] Drawing 8 shows the relation between the distance (1.0 micrometers, 2.0 micrometers, 3.0 micrometers) from the floatation side of internal-surface 32a of said opening 32, and the height of the up magnetic pole 20. The average of the height of the up magnetic pole 20 of the first stage before ** performs ion milling, and ** show the average of the amount of loss of weight of the up magnetic pole 20 after ion milling, and - shows the average of the height of the up magnetic pole 20 after ion milling. Even if variation is in the height in early stages of the up magnetic pole 20 when the distance from the floatation side of internal-surface 32a of opening 32 is 1.0 micrometers - 3.0 micrometers so that clearly from drawing 8 , it turns out that the height of the up magnetic pole 20 after ion milling is equalized (about 3 micrometers).

[0033] Although the suitable example was given per this invention above and many things were explained, as for this invention, it is needless to say that many can be changed within limits which are not limited to this example and do not deviate from the pneuma of invention.

[0034]

[Effect of the Invention] When a lower magnetic pole is etched by ion milling according to the manufacture approach of the MR head concerning this invention, Said lower magnetic pole corresponding to an up magnetic pole head side and this up magnetic pole head side is exposed by opening. The distance from the floatation side of the opening wall by the side of an up magnetic pole head forming the 2nd resist coat whose thickness is 10-15 micrometers by 1-3 micrometers, and rotating a substrate By carrying out necessary depth etching of the lower magnetic pole which irradiated the ion beam by the angle of incidence of arbitration other than 0 degree, and was exposed in said opening by using the 2nd resist coat as a mask The shadowing effectiveness (electric shielding) of an ion beam arises by the 2nd resist coat. Since the exposure rate of the ion beam which carries out incidence to the point of an up magnetic pole changes with thickness of an up magnetic pole, the amount of etching increases, so that thickness is thick, and the amount of etching decreases so that thickness is thin, even if variation is in thickness (plating thickness) On the whole, the height of the point of an up magnetic pole can be arranged, it writes in and the stable MR head with a property can be offered.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The explanatory view in the condition of having formed the non-magnetic material layer on the lower magnetic pole,
[Drawing 2] A coil layer, an insulating layer, the fragmentary sectional view in the condition of having formed the up magnetic pole,
[Drawing 3] The explanatory view in the condition of having formed the 1st resist coat,
[Drawing 4] The explanatory view in the condition of having removed the non-magnetic material layer by reactive ion etching,
[Drawing 5] The explanatory view in the condition of having formed the 1st resist coat,
[Drawing 6] The explanatory view showing the example of the exposure range of an ion beam,
[Drawing 7] The graph which shows the relation between the height of an up magnetic pole, and the amount of loss of weight by ion milling,
[Drawing 8] The graph which shows the location of the 2nd resist coat, and relation with the amount of loss of weight of an up magnetic pole etc.,
[Drawing 9] The front view seen from the floatation side side of an MR head,
[Drawing 10] It is the fragmentary sectional view of ID head section of an MR head.
[Description of Notations]
10 Magneto-resistive Effect Mold Head,
12 Inductive Head,
13 Lower Magnetic Pole
20 Up Magnetic Pole
20a Point
21 Non-magnetic Material Layer
24 26 Insulating layer
25 Coil Layer,
28 1st Resist Coat,
30 2nd Resist Coat
32 Opening
32a The internal surface of opening

[Translation done.]

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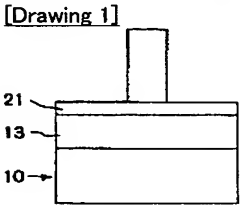
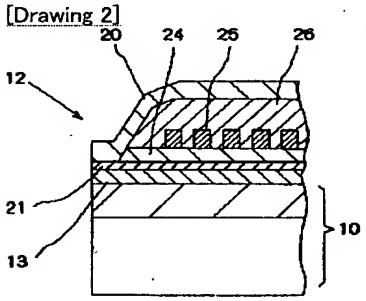
DRAWINGS

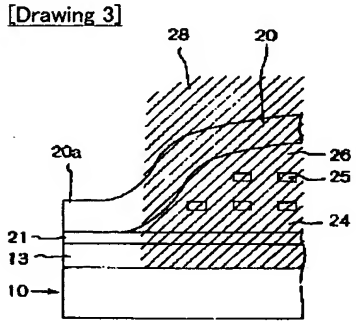
[Drawing 1]



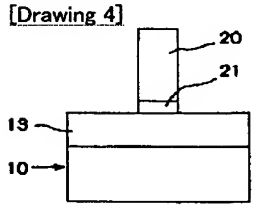
[Drawing 2]



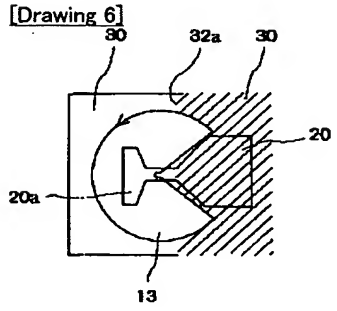
[Drawing 3]



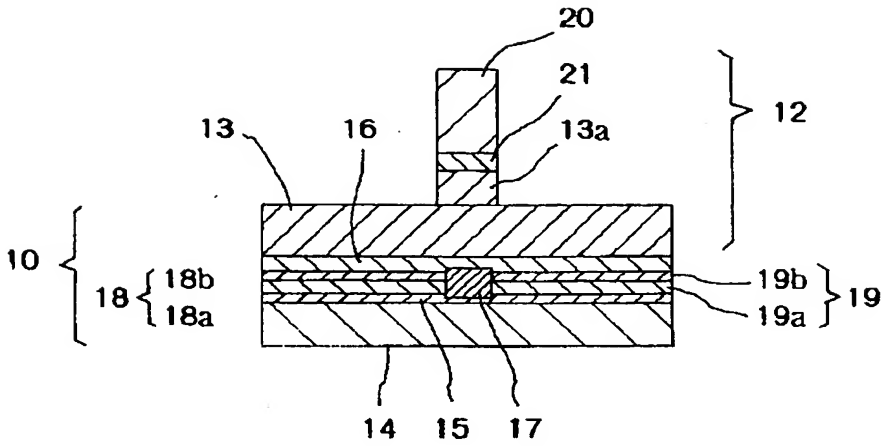
[Drawing 4]



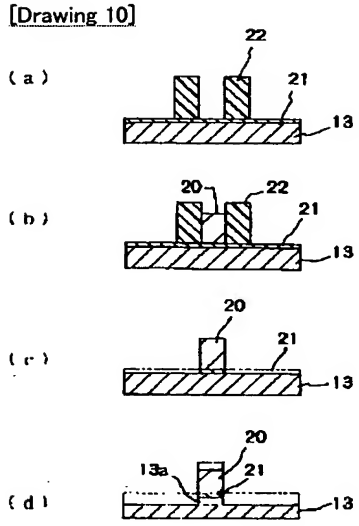
[Drawing 6]



[Drawing 5]



[Drawing 10]



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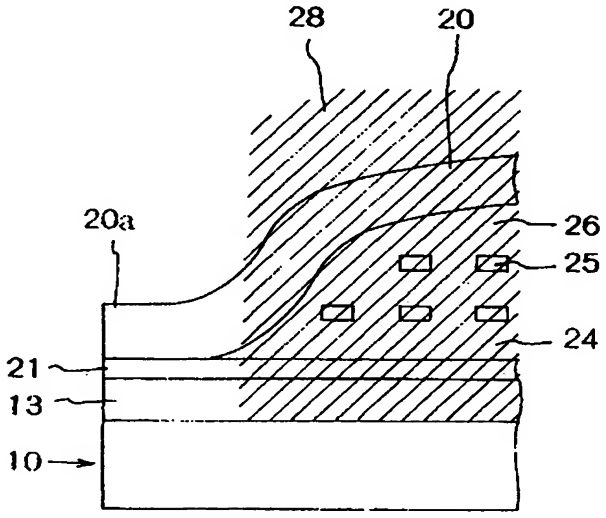
5D034 BA02 BA18 BB09 BB12 DA07

(54)【発明の名称】 ＭＲヘッドの製造方法

(57)【要約】 （修正有）
【課題】 上部磁極の高さのバラツキを極力解消し、安定した書き込み特性を有するＭＲヘッドを製造できるＭＲヘッドの製造方法を提供する。
【解決手段】 上部磁極先端部側と上部磁極先端部側に対応する下部磁極１３を開口部３２により露出させて、上部磁極先端部側の開口部内壁面３２ａの浮上面からの距離が１～３μｍで厚さが１０～１５μｍの第２のレジスト皮膜３０を形成する工程と、基板を回転させつつ、第２のレジスト皮膜３０をマスクとして、開口部３０内にイオンビームを０°以外の任意の入射角で照射して、露出した下部磁極１３を所要深さエッチングするイオンミリング工程と、第２のレジスト皮膜３０を除去する工程とを含むことを特徴とする。



ち、上記MRヘッドは基板（ウェーハ）上に多数作り込まれるのであるが、ウェーハはある面積を有することから、上記のように上部磁極２０をめっきにより作り込む際、ウェーハの周辺部側と中央部側とではめっき厚に差ができ、したがって、最終的に得られたMRヘッドの上部磁極２０に高さのバラツキが生じ、個々のMRヘッドで書き込み特性にバラツキが生じるという課題がある。

【００１１】そこで、本発明は上記課題を解決すべくなされたものであり、その目的とするところは、上部磁極の高さのバラツキを極力解消し、安定した書き込み特性を有するMRヘッドを製造できるMRヘッドの製造方法を提供するにある。

【００１２】

【課題を解決するための手段】本発明は上記目的を達成するため次の構成を備える。すなわち、磁気抵抗効果型ヘッドの磁気シールド膜を兼ねる下部磁極と、該下部磁極上に非磁性材料からなるギャップ層を介して形成される上部磁極と、下部磁極および上部磁極に絶縁して形成され、下部磁極と上部磁極に記録磁界を誘導するコイル層とが設けられたMRヘッドの製造方法において、基板上に、前記下部磁極を含む多数の磁気抵抗効果型ヘッドを作り込む積層工程と、該下部磁極上に前記非磁性材料層を形成する工程と、該非磁性材料層上に前記下部磁極よりも幅の狭い前記上部磁極を形成する工程と、前記上部磁極先端部および該上部磁極先端部付近の前記非磁性材料層を露出させて形成した第１のレジスト皮膜をマスクとして露出した前記非磁性材料層を除去する反応性イオンエッチング工程と、該第１のレジスト皮膜を除去する工程と、前記上部磁極先端部側と該上部磁極先端部側に対応する前記下部磁極を開口部により露出させて、前記上部磁極先端部側の開口部内壁面の浮上面からの距離が１～３μmで厚さが１０～１５μmの第２のレジスト皮膜を形成する工程と、前記基板を回転させつつ、前記第２のレジスト皮膜をマスクとして、前記開口部内にイオンビームを０°以外の任意の入射角で照射して、前記露出した下部磁極を所要深さエッチングするイオンミリング工程と、前記第２のレジスト皮膜を除去する工程とを含むことを特徴としている。

【００１３】上記のように、イオンミリングにより下部磁極をエッチングする際、上部磁極先端側と該上部磁極先端側に対応する前記下部磁極を開口部により露出させて、上部磁極先端側の開口部内壁の浮上面からの距離が１～３μmで厚さが１０～１５μmの第２のレジスト皮膜を形成し、基板を回転させつつ、第２のレジスト皮膜をマスクとして、前記開口部内にイオンビームを０°以外の任意の入射角で照射して、露出した下部磁極を所要深さエッチングすることにより、第２のレジスト皮膜によりイオンビームのシャドーイング効果（遮蔽）が生じ、上部磁極の先端部に入射するイオンビームの照射割合が上部磁極の膜厚により異なり、膜厚が厚い程エッチング量が多くなり、膜厚が薄い程エッチング量が少なくなることから、膜厚（めっき厚）にバラツキがあっても、全体的に上部磁極の先端部の高さが揃うようになる。

【００１４】前記非磁性材料に、SiO_2、Ta_2O_5、Si_3N_4、TiO、WO_3の１種または２種以上の非磁性材料を用いることができる。また、反応性イオンエッチング工程は、CF_4とO_2の混合ガスを用い、前記基板をカーボントレイ上に載置して行うと好適である。また、反応性イオンエッチング工程は、CHF_3のガスを用い、前記基板を石英トレイ上に載置して行うこともできる。

【００１５】

【発明の実施の形態】以下、本発明の好適な実施の形態を添付図面に基づいて詳細に説明する。本実施の形態において、基板（ウェーハ）上に磁気抵抗効果型ヘッド１０を作り込む工程は従来工程をそのまま採用し得るので説明は省略する。なお、磁気抵抗効果型ヘッド１０の構成は必ずしも図９に示すものに限られない。

【００１６】図１に示すように、形成された磁気抵抗効果型ヘッド１０の上部シールド膜を兼用する下部磁極１３上に非磁性材料層２１（ギャップ層）を形成する。非磁性材料層２１の材質は、後記する反応性イオンエッチングにより除去できる材料、例えば、SiO_2、Ta_2O_5、Si_3N_4、TiO、WO_3の１種または２種以上の膜をスパッタリングによって形成する。非磁性材料層２１の厚さはIDヘッドの磁気ギャップとなるものであり、概ね０．２５μm程度とする。

【００１７】この非磁性材料層２１上の所要位置に、図２に示すように絶縁層２４、コイル層２５を公知の工程により形成する。コイル層２５は、下部磁極と上部磁極に記録磁界を誘導するものである。次に、同図に示すように、従来と同様にして、非磁性材料層２１上、およびコイル層２５上に絶縁層２６を介して下部磁極１３よりも幅の狭い上部磁極２０をめっきにより形成する。上部磁極２０はNiFe（パーマロイ）合金である。広い面積のウェーハ上にめっきにより上部磁極２０を形成するので、この時点で、従来と同様に、多数のMRヘッド間での上部磁極２０に厚さのバラツキが発生することは否めない。

【００１８】次に、図３に示すように、上部磁極２０の先端部２０ａおよび該上部磁極先端部２０ａ付近の非磁性材料層２１が露出するように第１のレジスト皮膜（斜線部）２８を形成する。次いでこの第１のレジスト皮膜２８をマスクとして、反応性イオンエッチングを行い、上部磁極２０先端部２０ａの周囲に露出する非磁性材料層２１を除去する（図４）。この反応性イオンエッチングでは、上部磁極２０はほとんどエッチングされない。

【００１９】反応性イオンエッチングは例えば次の条件で行う。チャンバー内に配置したカーボントレイ上にウ

値、□はイオンミリング後の上部磁極２０の目減り量の平均値、●はイオンミリング後の上部磁極２０の高さの平均値を示す。図８から明らかなように、開口部３２の内壁面３２ａの浮上面からの距離が１．０μｍ～３．０μｍの場合、上部磁極２０の初期の高さにバラツキがあっても、イオンミリング後の上部磁極２０の高さが平均化（約３μｍ）されることがわかる。

【００３３】以上本発明につき好適な実施例を挙げて種々説明したが、本発明はこの実施例に限定されるものではなく、発明の精神を逸脱しない範囲内で多くの改変を施し得るのはもちろんである。

【００３４】

【発明の効果】本発明に係るＭＲヘッドの製造方法によれば、イオンミリングにより下部磁極をエッチングする際、上部磁極先端側と該上部磁極先端側に対応する前記下部磁極を開口部により露出させて、上部磁極先端側の開口部内壁の浮上面からの距離が１～３μｍで厚さが１０～１５μｍの第２のレジスト皮膜を形成し、基板を回転させつつ、第２のレジスト皮膜をマスクとして、前記開口部内にイオンビームを０°以外の任意の入射角で照射して、露出した下部磁極を所要深さエッチングすることにより、第２のレジスト皮膜によりイオンビームのシャドーイング効果（遮蔽）が生じ、上部磁極の先端部に入射するイオンビームの照射割合が上部磁極の膜厚により異なり、膜厚が厚い程エッチング量が多くなり、膜厚が薄い程エッチング量が少なくなることから、膜厚（めっき厚）にバラツキがあっても、全体的に上部磁極の先端部の高さを揃えることができ、安定した書き込み特性を有するＭＲヘッドを提供できる。

【図面の簡単な説明】

【図１】下部磁極上に非磁性材料層を形成した状態の説明図、

【図２】コイル層、絶縁層、上部磁極を形成した状態の部分断面図、

【図３】第１のレジスト皮膜を形成した状態の説明図、

【図４】非磁性材料層を反応性イオンエッチングで除去した状態の説明図、

【図５】第１のレジスト皮膜を形成した状態の説明図、

【図６】イオンビームの照射範囲の例を示す説明図、

【図７】上部磁極の高さとイオンミリングによる目減り量との関係を示すグラフ、

【図８】第２のレジスト皮膜の位置と上部磁極の目減り量等との関係を示すグラフ、

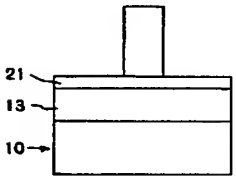
【図９】ＭＲヘッドの浮上面側から見た正面図、

【図１０】ＭＲヘッドのＩＤヘッド部の部分断面図である。

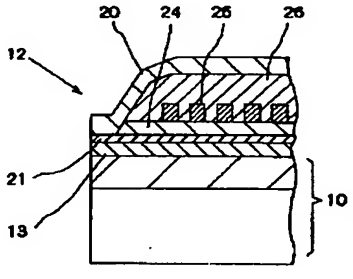
【符号の説明】

１０　磁気抵抗効果型ヘッド、
１２　インダクティブヘッド、
１３　下部磁極
２０　上部磁極
２０ａ　先端部
２１　非磁性材料層
２４、２６　絶縁層
２５　コイル層、
２８　第１のレジスト皮膜、
３０　第２のレジスト皮膜
３２　開口部
３２ａ　開口部の内壁面

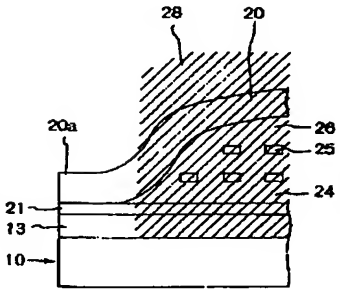
【図１】



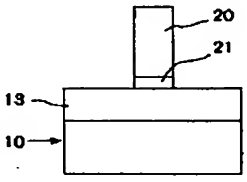
【図２】



【図３】



【図４】



【図６】